IJTRET "Voice of Innovative Minds"
doi.org/10.54473/IJTRET.2024.8306
International Journal of Trendy Research in Engineering and Technology
Volume 8 Issue 3 June 2024
ISSN No.2582-0958

UTILIZATION OF POWER GRID USING AGILE MANUFACTURING TECHNIQUES

Mr. Rajath S R[1], Prof. Rohith M N [2]
[1] Post Graduate Student, [2]Assistant Professor, Department of Electronics and Communication Engineering
Sri Jayachamarajendra College of Engineering, JSS Science and Technology University, Mysuru-570006
Corresponding Author: gowdarajath93@gmail.com

Received 18 May 2024 Received in Revised form 21 May 2024 Accepted 24 May 2024
Available online 04 June 2024

ABSTRACT

The utilization of power grids within the context of agile manufacturing is a multifaceted concept that entails the integration of smart grid technology and agile manufacturing ideas. This paper provides an overview of ways agile manufacturing practices can enhance the performance, reliability, and sustainability of power grid usage. Agile manufacturing is a method focused on flexibility, responsiveness, and adaptability in manufacturing techniques. When implemented in the usage of power grids, agile production standards can revolutionize how strength is generated, transmitted, dispensed, and eaten up. This integration targets optimizing power usage, lessening waste, decorating grid resilience, and supporting the integration of renewable electricity resources.

Keywords—Agile Manufacturing, utilization of power grid.

I.INTRODUCTION

It is envisioned that over 70% of the world's population may be dwelling in cities with the aid of 2050, to be able to end in a fast improvement of smart cities around the world[1]. In addition, with the emerging development of the Internet of Things and energy net in distribution strength grid combined with the increasing ability of renewable strength and load inclusive of electric powered cars, the development of the grid is quicker than ever. All those elements make it essential to have an accurate and powerful planning approach for the destiny distribution electricity grid. Some of the most latest studies for distribution energy grid planning take the attention of renewable strength and multiple loads. Some other researchers don't forget the impact of the load aspect on the distribution energy grid together with strength garage devices and electric cars. Other research recognition on the gird equipment or the policy from authorities to distribution strength grid making plans.

Power grid planning is an important thing of Destiny metropolis's development and its importance has been well known [2]. A lot of researchers have been studying in this field. Traditional distribution electricity grid planning for clever cities is commonly based totally on economic and populace development. For instance, some of the most recent studies consist of distribution system enlargement-making plans, PV-making plans thinking about overload troubles, and large-scale wind energy planning for enough users. Some different researchers are aware of massive-grid planning, in Gao and his team's [3] attention at the electricity grid reinforcement the use of nation enumerate approach, while Wintzek et al[4] https://www.mdpi.com/2673-4826/2/4/35 focus at the voltage balance for the urban grid. For the past few years, the expansion of energy grid planning has brought huge advantages to people globally. The increase in strength consumption and prosperity in present-day towns proved the conventional growth grid planning technology useful for the past few decades. However, as the sector's aging troubles combined with political and public fitness incidents which include exchange conflict and the unfolding of Coronavirus, the economy around the arena has been getting worse and will lead to more shrinking towns around the sector. As a result, traditional energy grid-making plans era cannot be practiced in these shrinking cities. In Japan, almost 30% of the entire populace is above 65 years old. In the USA, cities in regions such as Michigan have critical population loss issues. In Argentina, the economy has encountered extreme recession in the past years. In China, the idea of shrinking towns has drawn extra attention utilizing researchers and authority officers. How to provide a sufficient and modernized energy grid planning generation for shrinking towns is a major hassle for energy engineers worldwide.

To deal with this hassle, this paper first analyzed a few traditional characteristics of shrinking towns. Second, designed an assessment index to assess the destiny improvement level for one-of-a-kind cities. Factors together with populace, financial, and natural troubles are taken into consideration. During the second component, the towns are divided into three secondary-degree classes which might be increasing, moderately developing, and shrinking primarily based on the evaluation approach and similarly into 1/3-level classes. At the stop, an advised distribution electricity grid planning technique is furnished for every class of towns as a reference for electricity engineers around the sector. Some of the innovative shrinking town electricity grid-making plans technology are also added. The outcome of this paper will provide a

distribution strength grid-making plans approach to thinking about the destiny development of towns. For expanding cities, it's going to offer a strong grid-making plans approach to help the fast monetary development and a booming population of the town. For mild developing towns, it'll provide an idea of ways conventional distribution electricity gird upgrading to destiny clever grid. For shrinking cities, the planning technologies will attention to clever grid transformation supported with the aid of efficient and powerful investment of electricity companies. By applying this making plans technology, a safe, green, and enough energy grid can be constructed for exclusive improvement sorts of cities.

II. LITERATURE SURVEY

Guangyuan SHI et al [2] in their paper first proposed a strength grid evaluation approach to provide statistics about whether the grid desires similar construction or no longer, compared to the development of the town. In addition, the development of electrical automobiles, 5G stations, and renewable power in clever towns are taken into consideration. Second, for the energy grid which desires additional construction, the grid planning technology is classified into 3 categories based on the use of the land. Third, an advised construction technique for voltage level, grid structure, electrical number one gadget configuration, strength distribution facility, and relay protection is furnished for each form of land. Concluded that in this way, a secure and green distribution power grid, primarily based on the particular needs of land utilization may be built.

GUO et al [3] initially designed an evaluation index to evaluate the future development stage for exceptional cities, for which factors including populace, economic, political issues, and energy grid are taken into consideration. Then, the towns are divided into 3 secondary-stage classes that are increasing, moderately growing, and shrinking primarily based on the evaluation method. Those three classes are further divided into 0.33-degree categories based on the aggregate of rising and falling Gross Domestic Product (GDP), population, and strength consumption. Last, a recommended distribution power grid planning approach is supplied for an exclusive variety of towns as a reference for energy engineers around the arena. Also, factors including renewable strength and electric-powered automobiles are considered. By applying this planning technology, a safe, efficient and enough strength grid can be constructed for distinctive development types of towns.

Wei et al [5] in their paper ‘Study on Construction Scheme of Power Grid Side Storage Station’ reported that the grid-facet strength storage device can alleviate the stress of the strength grid at top load, and make full use of the idle resources of the strength grid at low load, with a purpose to improve the overall utilization price of the energy grid. The software situation, admission to the system, and operation management of grid-side electricity garage machines are studied. They have proposed a regular grid-aspect energy storage power station construction scheme. This scheme can be specifically utilized in suburban junction substations with speedy financial development, offering a new answer for areas with seasonal power gaps.

III . MODEL OF UTILIZATION OF POWER GRID

The waterfall version can be carried out to the usage of electricity grids, especially within the context of infrastructure development, system design, and huge-scale initiatives. The waterfall model is a traditional sequential method to software improvement, where progress flows gradually downwards through wonderful phases: requirements gathering, layout, implementation, testing, deployment, and renovation. Here's how it could be tailored for strength grid usage as shown in

fig 1 below.

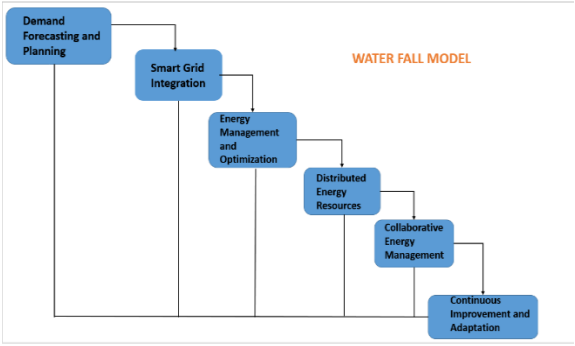

Fig: 1 The model of the utilization of the power grid

A. Demand Forecasting and Planning:

Utilize information analytics and machine-getting-to-know algorithms to forecast electricity demand patterns based on historic statistics, market traits, and real-time inputs. Develop agile production schedules that align with forecasted calls, thinking of electricity availability, pricing, and grid constraints.

B. Smart Grid Integration:

Deploy clever meters, sensors, and automation systems inside production centers to monitor energy intake, equipment overall performance, and grid conditions in actual time. Implement demand reaction talents to modify manufacturing strategies or shift energy usage during top call for intervals, optimizing grid sources and lowering prices.

C. Energy Management and Optimization:

Utilize power management systems (EMS) to optimize electricity use, decrease waste, and prioritize renewable electricity assets in the production procedure. Implement strength-efficient technology, together with LED lights, variable speed drives, and energy recuperation systems, to lessen average power consumption.

D. Distributed Energy Resources (DERs):

Integrate on-website online renewable electricity sources, power storage structures, and microgrids to beautify energy resilience, lessen reliance on the main grid, and take part in grid offerings. Explore possibilities for power sharing or peer-to-peer buying and selling among neighboring manufacturing centers to balance energy hundreds and beautify grid balance.

E. Collaborative Grid Management:

Establish collaborative partnerships with utilities, grid operators, and strength provider carriers to alternate records, share insights, and coordinate grid operations effectively. Participate in grid-balancing tasks, inclusive of digital electricity flora (VPPs) or demand-facet management programs, to provide ancillary services and guide grid stability.

F. Continuous Improvement and Adaptation:

Implement agile principles of iterative improvement, feedback loops, and non-stop getting-to-know to refine strength control strategies, optimize useful resource allocation, and adapt to converting grid dynamics. Leverage superior analytics, simulation tools, and scenario-making plans to assess the impact of different manufacturing eventualities on strength intake, expenses, and grid performance. By integrating these factors right into a cohesive version, producers can leverage agile production strategies to beautify the utilization of strength grids, enhance energy efficiency, lessen environmental impact, and contribute to a greater resilient and sustainable energy infrastructure.

IV . CASE STUDY

Power grid utilization in homes

Let's delve into a case observation that specializes in strength grid usage in houses, especially comparing households in specific settings: Urban Apartments (Household A) and Suburban Single-Family Homes (Household B). This case looks at highlights how region, property kind, lifestyle, technological integration, and grid interaction affect energy grid usage in homes. Balancing energy wishes, adopting green technology, and integrating renewable assets are key strategies for sustainable power use in residential settings as shown in Fig 2 below.

Household A: Urban Apartment

- Location and Setting:

  Household A is situated in a densely populated city region inside an excessive-rise condominium building. The condominium has restricted space and can have restrictions on energy-extensive modifications.
- Population Density and Lifestyle:

  The surrounding location has a high populace density, leading to a higher typical electricity demand within the neighborhood. The lifestyle in urban apartments frequently involves citizens running long hours and the usage of electricity-in-depth appliances all through restrained time windows.
- Energy Consumption Profile:

  Heating and cooling requirements are slight because of shared partitions and weather management systems inside the building. Energy consumption is in particular driven by way of electronics (TVs, computer systems, gaming consoles), lights, and kitchen home equipment.
- Technological Integration:

  Smart home gadgets consisting of clever thermostats, strength-green lighting, and occupancy sensors may be incorporated to optimize strength utilization. The limited area may additionally restrict the installation of solar panels or electricity storage structures.
- Grid Interaction:

  Household A is a part of a larger grid community serving multiple apartments and buildings. Peak energy call in the vicinity takes place in the course of evenings and mornings whilst residents are active, requiring grid stability and cargo control.

Household B: Suburban Single-Family Home

- Location and Property Type:

  Household B is located in a suburban area with decreased population density and more area.
  The unmarried-own family home has a yard and adequate roof area for strength-associated installations.
- Population Density and Lifestyle:

  Suburban areas usually have decreased population density, resulting in less pressure on the nearby electricity grid. Residents may have one-of-a-kind lifestyle styles, such as extra time spent at domestic, outdoor sports, and larger households.
- Energy Consumption Profile:

  Heating and cooling requirements range with the weather but can be higher due to large dwelling spaces. Energy utilization consists of HVAC systems, appliances (fridge, washing machine/dryer), domestic workplace system, and out-of-door lighting/landscaping.
  - Technological Integration:

  Household B may additionally have greater possibilities for renewable strength integration, including sun panels, because of available roof space.
  Smart home technology, inclusive of electricity monitoring systems and programmable thermostats, are commonplace to optimize strength utilization.
- Grid Interaction:
  The single circle of relatives' homes is a standalone unit but is still related to the wider strength grid

  Peak power calls may additionally align with nighttime hours whilst citizens go back from paintings and engage in household activities.

V . COMPARISON AND OBSERVATIONS:

- Energy Consumption Patterns:

Household A (Urban Apartment) has an extra compact living area and may rely upon shared constructing infrastructure for heating/cooling, impacting strength usage.

Household B (Suburban Single-Family Home) has numerous strength desires, such as outside lighting fixtures/landscaping and doubtlessly better HVAC demands.

- Technological Integration:

Both families can gain from clever technologies, however, Household B may additionally have greater opportunities for renewable strength integration and power-efficient upgrades because of property traits.

- Grid Impact:

Urban areas with high-density housing (like Household A) contribute to localized top calls, requiring grid management strategies.
Suburban homes (like Household B) unfold out peak electricity utilization more lightly but might also have sporadic spikes all through particular sports (e.g., cooking, and laundry).

- Future Trends:

Both households may additionally trend towards strength-efficient appliances, renewable strength adoption, and grid-linked garage solutions to reduce reliance on the conventional power grid.

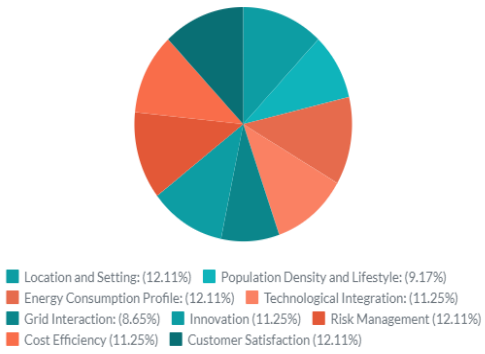

Fig: 2 Pie Chart for Model A and Model B

Using traditional approach and agile manufacturing for utilization of power grid as shown in fig 3 below.

In the context of strength grid utilization, the traditional approach and agile manufacturing method vary considerably in various factors.

- The conventional approach well-known shows limited flexibility in adapting to changing needs and situations, often sticking to predefined plans which hinders short-term version to market shifts. In comparison, the agile manufacturing method is particularly bendy, accommodating changes in call for, useful resource availability, and grid situations seamlessly. This flexibility allows for more green and resilient power grid operations.

- Response time beneath the conventional method is usually longer whilst incorporating new technology or adjusting to market dynamics. The rigid and linear nature of this approach slows down the integration system. Conversely, the agile approach leverages iterative and adaptive methods, resulting in a miles shorter reaction time. This enables fast integration of recent technologies and timely market changes, retaining the power grid more responsive and updated.

- Resource allocation in a conventional setup is frequently constant and primarily based on forecasted calls that can result in both underutilization or overutilization of resources. This constant allocation affects inefficiencies and capability wastage. Agile production, however, uses dynamic useful resource allocation based totally on real-time calls for alerts, optimizing usage and minimizing waste, thereby making sure of an extra green energy grid.

- Adaptability is every other crucial element in which traditional methods fall quickly. They are much less adaptable to unexpected disruptions or marketplace modifications because of their rigid shape. Agile manufacturing, however, is designed to be greater adaptable via iterative planning and speedy decision-making, making it better acceptable to handle disruptions and shifts in marketplace developments efficiently.

- Collaboration in the traditional method is regularly constrained, with stakeholders running in silos and choice-making tactics being remoted. This can result in communication gaps and inefficiencies. Agile manufacturing promotes stronger collaboration among stakeholders through move-practical groups and transparent conversation channels, fostering a greater cohesive and efficient operation.

- Innovation tends to be slower in traditional strategies because of rigid procedures and hierarchical structures, which can stifle new thoughts. Agile production enables a quicker pace of innovation via a tradition of experimentation, continuous improvement, and expertise sharing, using greater modern answers in strength grid control.

- Risk management within the traditional technique is usually reactive, with restricted foresight into capacity disruptions. This reactive stance can bring about better vulnerability to surprising events. Agile production takes a proactive technique to chance control, emphasizing early identification of risks and growing mitigation strategies, thereby lowering the effect of capacity disruptions.

- Cost performance below conventional methods is often lower due to inefficiencies in aid usage and slower responses to market changes, leading to better operational prices. Agile manufacturing improves value performance by optimizing useful resource usage, reducing downtime, and improving productivity, thus lowering average fees.

Finally, client delight can vary under the conventional approach because of inconsistencies in carrier shipping

and responsiveness. Agile manufacturing, with its focus on improved provider pleasant, reliability, and responsiveness, generally outcomes in better consumer pleasure. This client-centric technique guarantees that the electricity grid meets the wishes and expectations of its customers greater efficiently.

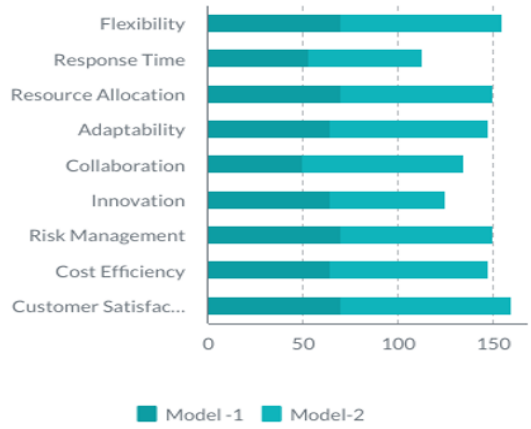

Fig: 3 Graph of Traditional approach and agile manufacturing.

VI. DISCUSSION

This block diagram model offers a visual illustration of the important thing additives and interactions worried in leveraging agile manufacturing principles for optimizing electricity grid usage. Each block represents a crucial aspect of agile grid management, contributing to a greater efficient, flexible, and resilient power grid as shown in fig 4 below.

Fig: 4 The model of optimizing electricity grid usage

1. Agile Grid Utilization: Represents the overarching idea of making use of agile manufacturing principles to strengthen grid management.
2. Flexibility & Adaptability: Refers to the capacity of the grid to quickly adapt to changing energy demand, integrate renewable assets, and respond to grid disruptions.
3. Modular & Scalable Solutions: Encompasses modular grid components, along with microgrids, allotted generation, and strength garage that can be customized and expanded as wished.
4. Real-Time Data & Analytics: Involves superior grid tracking structures, clever meters, and predictive analytics for data-pushed decision-making and optimization of grid operations in actual time.
5. Collaborative Ecosystem: Represents collaborative efforts among stakeholders, utilities, technology companies, and purchasers to power innovation, shared infrastructure, and grid modernization initiatives.
6. Continuous Improvement & Innovation: Focuses on ongoing innovation in grid technology, energy control practices, and renewable power integration to decorate grid performance and sustainability.
7. Risk Management & Resilience: Includes risk assessment, contingency-making plans, and grid resiliency measures to mitigate risks, make certain grid reliability, and withstand disruptions.

VII. CONCLUSION

Making use of agile manufacturing techniques to strengthen grid utilization offers several sizable blessings and consequences as shown in Fig 5 below.

1. Enhanced Flexibility and Adaptability: Agile methodologies permit the energy grid to speedy reply to changing strength calls for, combine renewable electricity assets, and manage grid disruptions. This flexibility ensures the most suitable usage of sources and better alignment with fluctuating strength desires.
2. Efficient Resource Allocation: Modular and scalable solutions permit efficient resource allocation, such as deploying microgrids, disbursed generation gadgets, and strength garage structures. These answers optimize grid performance, reduce congestion, and beautify average resource usage.
3. Data-driven decision-making: Real-time information series, analytics, and tracking systems empower grid operators to make knowledgeable decisions, discover inefficiencies, and optimize grid operations in real-time. Data-driven insights improve grid efficiency, reduce power losses, and guide effective call-for-side control strategies.
4. Collaborative Ecosystem: Agile methodologies foster collaboration among stakeholders, utilities, technology companies, and clients. This collaborative ecosystem promotes innovation, shared infrastructure, and joint tasks for grid modernization, renewable energy integration, and grid flexibility enhancement.
5. Continuous Improvement and Innovation: Embracing continuous improvement and innovation drives ongoing advancements in grid technologies, electricity management practices, and renewable electricity integration. This affects stepped-forward grid

performance, reliability, and purchaser satisfaction whilst assisting environmental sustainability dreams.

6. Risk Management and Resilience: Integrating change management practices, such as grid modeling, contingency-making plans, and resilience measures, complements the grid's ability to face up to disruptions, cyber threats, and operational challenges. A resilient grid infrastructure improves reliability, minimizes downtime, and guarantees uninterrupted strength supply.

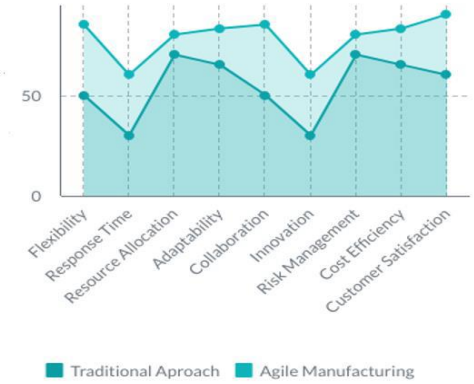

Fig: **5** Graph of Traditional Approach v/s Agile manufacturing

Overall, leveraging agile manufacturing strategies in strength grid utilization results in a greater responsive, efficient, and sustainable power grid. The mixture of flexibility, records-pushed selection-making, collaboration, continuous improvement, and risk management complements grid performance, helps renewable strength integration, and meets evolving power demands whilst ensuring grid reliability and resilience.

VIII. FUTURE WORK

The destiny scope of utilizing agile manufacturing techniques in strength grid management consists of enhancing flexibility, optimizing useful resource allocation, leveraging actual-time data analytics, fostering collaboration, selling continuous development, enhancing grid resilience, and turning in consumer-centric strength solutions. These improvements can result in more green, reliable, and sustainable strength grid surroundings capable of assembly destiny electricity challenges and demands

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